

Three kinds of selection, and Hardy-Weinberg HL

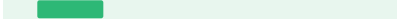
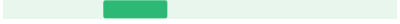
60 minutes • D4.1.12 to D4.1.14 • Chapters 9, 10

Directional, stabilising and disruptive selection, and using the Hardy-Weinberg equation and its conditions

BY THE END, STUDENTS CAN

- ☐ Distinguish directional, stabilising and disruptive selection, and explain why all three change allele frequencies
D4.1.12
- ☐ Use the Hardy-Weinberg equation to calculate allele and genotype frequencies, and say what its five conditions tell you
D4.1.13, D4.1.14

TIMING

0-5	5 min	Do now	
5-15	10 min	Three curves	
15-25	10 min	The square	
25-45	20 min	Problem set	
45-55	10 min	Switch off a condition	
55-60	5 min	Exit	
60 min One lesson			

STARTER

- 5 min Do now**
- Draw a bell curve for beak depth. Shade the part that a pressure removes and redraw the population after, for the pressure the teacher names: a sudden cold snap that only kills small birds. Which kind of selection is it?

ON THE BOARD, FROM THE GUIDE

Open the guide on the projector at each chapter (the links work in this PDF). Every figure plays from its own buttons, and the lesson's slides have the same figures, step by step, in the order of this plan.

09 Three ways selection can act

CHAPTER 09 IN THE SLIDES

Step through the figure (3 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

- 1. Directional:** one tail of the curve is removed, and the whole curve shifts. Alleles for large beaks become commoner.
- 2. Stabilising:** both tails are removed and the curve narrows. Alleles for the extremes become rarer.
- 3. Disruptive:** the middle is removed and the curve splits in two. Alleles for both extremes become commoner.

Play the animation, Watch it happen: one population, three kinds of selection. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

- One population of 150 finches: how deep each beak is. One gene adds about 1.6 mm for each **D** allele; other genes and food add the rest. **D** is 30% of the alleles.
- The survivors breed. Their mean moves deeper, and **D** rises from 30% to 61% of the alleles they pass on.
- The spread narrows. **D** still shifts, 30% to 35%: the favoured middle is mostly Dd, so more D is kept than before.
- Two peaks are left. The middle was mostly Dd, so **D** falls, 30% to 24%. All three kinds change allele frequency.

Predict box: Babies of very low and very high birth weight are less likely to survive than babies of average weight. Which kind of selection is this? Hands up or mini whiteboards first.

Answer C: Stabilising selection, because both extremes are removed

Remember it: Drive Squeeze Divide (Directional, Stabilising, Disruptive).

10 What a population would be like if it were not evolving

CHAPTER 10 IN THE SLIDES

Step through the figure (4 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. Egg and sperm alleles meet at random. If the frequency of A is $p = 0.6$ and of a is $q = 0.4$, each edge of the square is split in those proportions.
2. The four areas are the four ways eggs and sperm can combine: p^2 , pq , pq and q^2 .
3. AA is $p^2 = 0.36$, Aa is $2pq = 0.48$ and aa is $q^2 = 0.16$. Together they make 1.
4. Working back: if 16% show the recessive trait, $q^2 = 0.16$, so $q = 0.4$ and $p = 0.6$.

Step through the figure (3 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. One gene, two alleles: p is the frequency of A, q of a, and $p + q = 1$. Here $p = 0.60$.
2. Hardy-Weinberg predicts the genotypes from p and q : $p^2 + 2pq + q^2 = 1$. When every condition is met, the counts fit.
3. It works backwards too. From the aa frequency, 1 in 2500: $q = 0.02$, $p = 0.98$, and **carriers** $2pq = 0.0392$, about 1 in 26.

Predict box: A recessive condition affects 1 person in 2500. Roughly how many people in the population are carriers (heterozygous)? Hands up or mini whiteboards first.

Answer A: About 1 in 25, since $2pq$ is about 0.04

Remember it: Large Rats Make Most Spaghetti (Large population, Random mating, Migration: none, Mutation: none, Selection: none).

THE LESSON

10
min

Three curves

Chapter 9's figure and the film, one kind at a time. Students use the Remember it tiles (Drive, Squeeze, Divide) and write one new example of each (the funnier the better) on the card below. Then the predict box on birth weight.

10
min

The square

Chapter 10's figure: why $p^2 + 2pq + q^2 = 1$. Students redraw the square for $p = 0.7$, then use it to find the genotype frequencies.

20
min

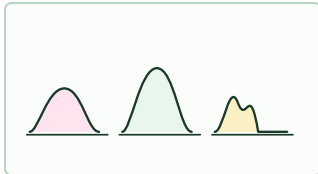
Problem set

The Hardy-Weinberg set below, in pairs, in order. Walk round for the common slip: q^2 is the frequency of the recessive genotype, not of the allele. Take the last problem as a class.

10
min

Switch off a condition

The Hardy-Weinberg tool in [chapter 10](#): turn off one condition at a time and describe what it does to the population against the prediction. Match each to a real case (a small island, inbreeding, a new mutation, a predator that takes one genotype, a new arrival).

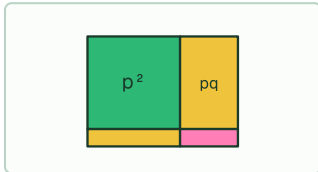


WRITING · HL

Three kinds of selection

Pairs invent one new example (funny is allowed, impossible is not) for each of directional, stabilising and disruptive selection, with a sketch of the curve before and after and a line saying which alleles become more common. Swap and check: does each example remove the right part of the curve?

Needs: mini whiteboards or squared paper.



PROBLEM SET · HL

Hardy-Weinberg problems

Six problems, in order. (1) A recessive trait with $q^2 = 0.25$: find q , p and the carriers. $q = 0.5$, $p = 0.5$, $Aa = 0.5$. (2) $p = 0.8$: genotype frequencies, and how many of 500 are Aa . 0.64 , 0.32 , 0.04 ; 160. (3) Of 1000 beetles, 360 are recessive: how many are AA and how many Aa ? $q = 0.6$, $p = 0.4$: AA 160, Aa 480. (4) Counts of 90 AA , 60 Aa and 50 aa : find the allele frequencies and say whether the population is in equilibrium. $A = 0.6$, $a = 0.4$; *expected* 0.36, 0.48, 0.16, *observed* 0.45, 0.30, 0.25, *so no: too few heterozygotes*. (5) A recessive condition affects 1 person in 10 000: roughly how many carry it? $q = 0.01$, $2pq = 0.0198$, *about 1 in 50*. (6) A gene at equilibrium has 0.32 heterozygotes: what are p and q ? 0.8 and 0.2 , or 0.2 and 0.8 : *you cannot tell which allele is which without one more genotype frequency*.

Needs: printed problems, calculators, a copy of [chapter 10](#)'s figure.

PLENARY

5
min

Exit

The five conditions from memory (the Remember it tiles), and which one is broken when the genotypes do not fit.

WHAT STUDENTS GET WRONG

Stabilising selection is no selection. It removes both extremes, so it still changes allele frequencies; only the average stays the same.

q^2 is the allele frequency. It is the frequency of the recessive genotype; q is the allele.

Recessive alleles disappear when they are harmful. Most copies are hidden in heterozygotes.

STRETCH AND SUPPORT

Support: the square for $p = 0.6$ pre-drawn, to colour in.

Stretch: in problem 6, what single extra fact would settle which allele is which?

IN THE GUIDE

- 9 [Three ways selection can act](#)
- 10 [What a population would be like if it were not evolving](#)
- All [The whole guide, with the figures that play](#)
- PPTX [This lesson's slides, in the order of this plan](#)

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- [Tarsia puzzle, dominoes and picture reveal](#) on D4.1, built from its key terms and ready to print
- A [pub quiz](#) with rounds on D4.1, to present or run with no projector
- An [escape room built from the question bank](#) on D4.1

ALREADY ON THE SITE FOR D4.1

- Lesson: [Hardy-Weinberg & Chi-Squared](#)
- Quiz: [Natural Selection \(HL\)](#)
- Quiz: [Natural Selection](#)
- Revision map: [D4.1 Natural selection](#), to fill in
- Exam questions: [D4.1 in the exam maker](#), a paper with its markscheme

CARD SETS ON SPLYCR

- Open a set to host it as a class game, or make a copy to edit.
- [D4.1 Natural Selection](#)

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on D4.1 at higher level each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?topics=D4.1&level=HL&paper=quiz&marks=15&src=ep



How this was made. The course structure, the activities and the teaching choices come from my own classroom, my presentations and my years of teaching IB and AP Biology. I use Claude, an AI, to help write and build the interactive guides, lesson plans, slides and practice questions, and to draw the diagrams and code the interactives. I direct the work and review it against the IB and AP specifications before it goes live.